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Contribution to the systematic knowledge of the genus *Ornithogalum* L. (*Hyacinthaceae*): morpho-anatomical variability of the leaves among different taxa

Abstract

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Comparative anatomy of leaf cross sections of fourteen *Ornithogalum* taxa is carried out: *O. orthophyllum* subsp. *baeticum*, *O. collinum*, *O. comosum*, *O. divergens*, *O. exscapum* var. *exscapum*, *O. exscapum* var. *ambiguum, O. exscapum* var. *parlatorei, O. gussonei*, *O. montanum, O. kochii* subsp. *monticola, O. refractum*, *O. televrinum*, *O. umbellatum* 3*x* (= *O. angustifolium*), *O. umbellatum* 4*x* (= *O. vulgare*). Analytical drawings are presented. Thirteen noteworthy leaf characters were quantified, organized in a data matrix (two more *Ornithogalum* species from literature were added) and finally analyzed through Neighbour Joining (NJ) and UPGMA methods. Leaf features in *Ornithogalum* result useful in order to group species, while often are not sufficient to characterize each single taxon.

Introduction

According to Speta (1998), the genus *Ornithogalum* L. comprises at least fifty species, distributed from the Mediterranean to W Afghanistan, showing the greatest diversity in the E Mediterranean (Zahariadi 1965). Since several decades, this taxonomically extremely difficult genus was the object of several studies on bulb structure and germination-type (Zahariadi 1962, 1965; Speta, 1990, 1990a, 1990b), classical cytotaxonomy (Peruzzi & Passalacqua 2002; Garbari & al. 2003; Tornadore & al. 2003; Aquaro & Peruzzi 2006 and literature cited therein), karyotype evolution (Raamsdonk 1986), chemotaxonomy (Øvstedal 1991), morphometry (Moret & al. 1991; Øvstedal 1991; Raamsdonk & Heringa 1987; Moret 1992; Moret & Galland 1992; Coskuncelebi & al. 2002), seed micromorphology (Coskuncelebi & al. 2000). At our best knowledge, there was no attempt to carry out an analytical and comparative study on leaf features, in order to test their possible taxonomic use. With this aim, we studied leaf cross-sections of fourteen *Ornithogalum* taxa from Central Mediterranean area.

Material and methods

The fourteen studied taxa are summarized in Table 1. Segments, 2-3 cm long, were taken from the basal third of leaves in springtime and fixed in a 50% ethylic alcohol 50% glycerol solution; afterwards, 40-50 µm wide cross sections were cut. Finally, camera lucida drawings were effected for each studied plant. We added also two more units (*O. kochii* subsp. *kochii*, *O. sibthorpii*) whose data were available in literature (Tab. 1).

Thirteen leaf features were organized in a data matrix (Tab. 2), subsequently analyzed through Neighbour Joining (NJ) and UPGMA methods under distance criterion defaults of PAUP 4.0b10 (Swofford 2002).

We selected as out-group one species of *Loncomelos* Raf. (*L. narbonensis*), following the results of Pfosser & Speta (1999), which clearly indicate the genera *Ornithogalum*, *Loncomelos* and *Honorius* S. F. Gray as monophyletic.

Table 1. Sources of the studied leaves and previous literature available on this matter: 1 - Tornadore (1986), 2 - Garbari & Giordani (1984), 3 - Speta (1990), 4 - Giordani & Garbari (1989), 5 - Speta (1990a), 6 - Zahariadi (1962), 7 - Speta (1990b).

Taxon	Label	Living plants	Lit.
Loncomelos narbonensis (L.) Raf.	LONAR	Italy: Rende (Cosenza): spontaneous in the Botanic Garden of Calabria University	1
O. orthophyllum subsp. *baeticum* (Boiss.) C. Zahariadi	BAETI	France: Les Vignes (Herault, Causse du Larzac), 2003 (cult. Hort. Bot. Calabria University, acc. n. 475)	\
O. collinum Guss.	COLLI	Sicily: Nebrodi, Cesarò, 2004 (cult. Hort. Bot. Calabria University, acc. n. 620)	2, 3
O. comosum L.	COMOS	Croatia: between Aržano and Kamensko, 2003 (cult. Hort. Bot. Calabria University, acc. n. 138)	\
O. divergens Boreau	DIVER	Italy: Calabria, Sila Piccola, loc. Ciricilla, 2002 (cult. Hort. Bot. Calabria University, acc. n. 749)	\
O. exscapum Ten. var. *exscapum*	EXSCA	Italy: Calabria, Sila Greca, loc. Sferracavallo, 2001 (cult. Hort. Bot. Calabria University, acc. n. 38, 264)	3
O. exscapum Ten. var. *ambiguum* (N. Terracc.) Fiori	EXAMB	Italy: Calabria, Sila Grande, banks of lake Cecita, 2001 (cult. Hort. Bot. Calabria University, acc. n. 271)	3
O. exscapum Ten. var. *parlatorei* Peruzzi et N. G. Passal.	EXPAR	Italy: Calabria, Mount Cocuzzo, 2001 (cult. Hort. Bot. Calabria University, acc. n. 110)	\

Table 1. (continued.)

O. gussonei Ten. (≡ *O. tenuifolium* Guss.)	GUSS	Sicily: Iblei, between Sortino and Buccheri, 2001 (cult. Hort. Bot. Calabria University, acc. n. 14)	3
O. kochii Parl. subsp. *kochii*	KOCHI	\	4
O. kochii Parl. subsp. *monticola* (Jord. & Fourr.) Peruzzi	MONTI	France: Alpes Maritimes, Saint Martin d'Entraunes, 2003 (cult. Hort. Bot. Calabria University, acc. n. 667)	5
O. montanum Ten.	MOSIR	Italy: Basilicata, Mount Sirino, 2002 (cult. Hort. Bot. Calabria University, acc. n. 19)	\
	MORUG	Italy: Basilicata, Pollino, Piano di Ruggio, 1997 (cult. Hort. Bot. Calabria University, acc. n. 315)	
	MOPAL	Italy: Calabria, Sila Greca, Paludi, 2002 (cult. Hort. Bot. Calabria University, acc. n. 603)	
	MOFIC	Sicily, Bosco della Ficuzza, 2002 (cult. Hort. Bot. Calabria University, acc. n. 497)	
O. refractum Kit. ex Willd.	REFCT	Italy: Calabria, Pollino, Castrovillari, 2001 (cult. Hort. Bot. Calabria University, acc. n. 248)	\
	REFCA	Italy: Calabria, Pollino, Alto di Cassano, 2002 (cult. Hort. Bot. Calabria University, acc. n. 161)	
	REFSIC	Sicily, Nebrodi, Tre Arie, 2001 (cult. Hort. Bot. Calabria University, acc. n. 629)	
O. sibthorpii Greuter (≡ *O. nanum* Sibth. & Smith)	SIBTH	\	6, 7
O. televrinum Speta	TELAR	Croatia: between Aržano and Kamensko, 2003 (cult. Hort. Bot. Calabria University, acc. n. 142)	3
	TELBI	Croatia: Biokovo, 2003 (cult. Hort. Bot. Calabria University, acc. n. 335)	
O. umbellatum L. 3*x* (= *O. angustifolium* Boreau)	UMBEL	France: Heyrieux (Isere), 2003 (cult. Hort. Bot. Calabria University, acc. n. 641)	\
O. umbellatum L. 4*x* (= *O. vulgare* Sailer)	VULGA	Italy, Tuscany, Empoli (Florence), 2004 (cult. Hort. Bot. Calabria University, acc. n. 180)	\

Results and Discussion

Cross sections of the leaves are reported in Figures 1-3. NJ and UPGMA trees are shown in Fig. 4. Both trees show very similar topologies, but for the placing of the two *O. televrinum* samplings, alternatively basal to *O. exscapum* group (under NJ) or to *O. umbellatum* group (under UPGMA).

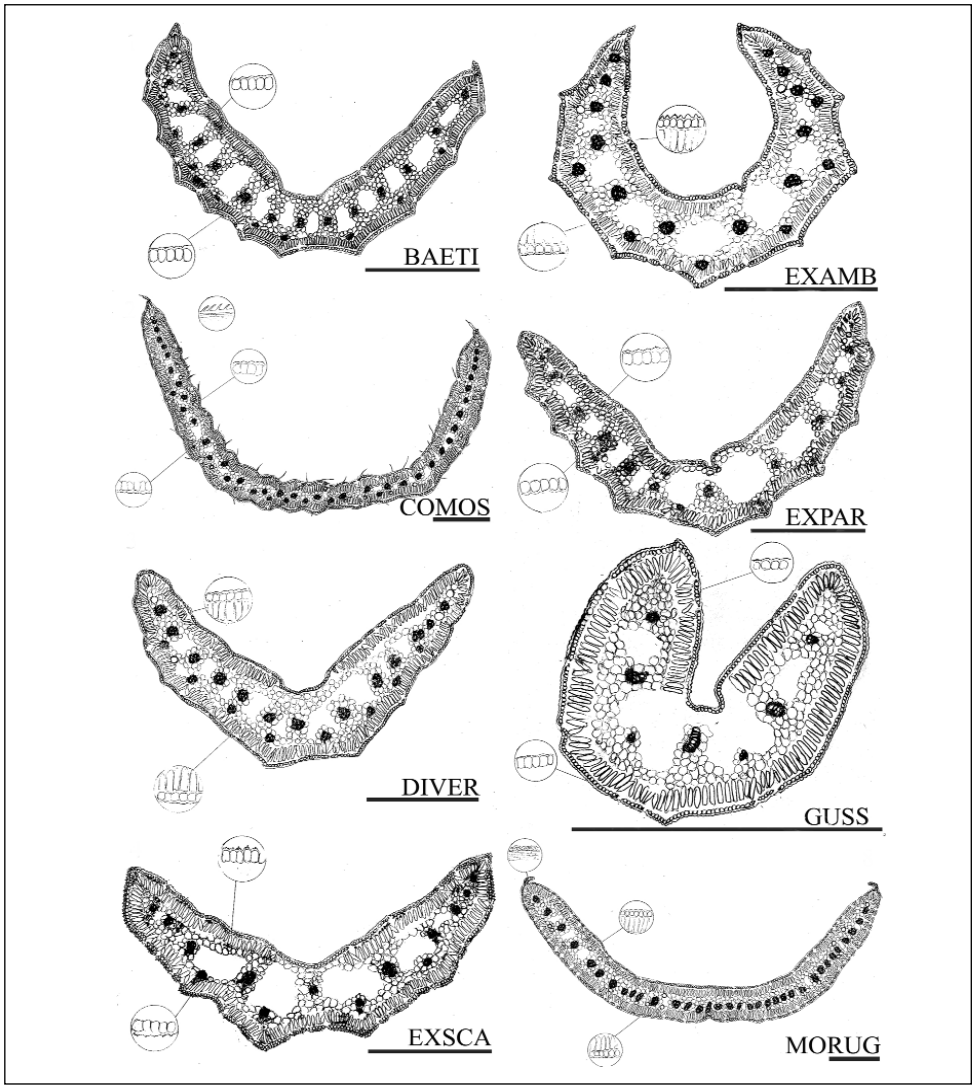

Fig. 1. Leaf cross sections: *O. orthophyllum* subsp. *baeticum* (BAETI), *O. comosum* (COMOS), *O. divergens* (DIVER), *O. exscapum* var. *exscapum* (EXSCA), *O. exscapum* var. *ambiguum* (EXAMB), *O. exscapum* var. *parlatorei* (EXPAR), *O. gussonei* (GUSS), *O. montanum* (MORUB); scale bars = 1 mm.

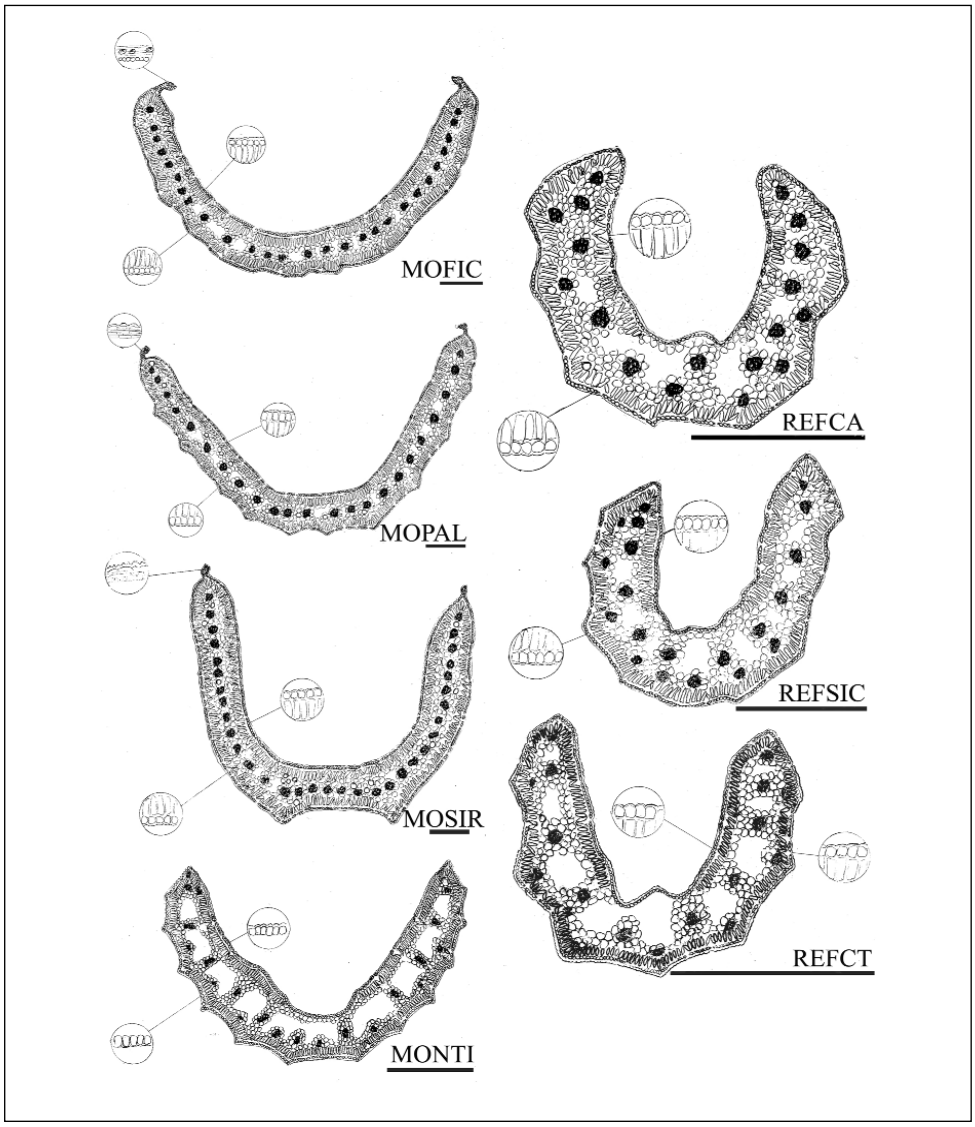

Fig. 2. Leaf cross sections: *O. montanum* (MOFIC, MOPAL, MOSIR), *O. kochii* subsp. *monticola* (MONTI), *O. refractum* (REFCA, REFSIC, REFCT); scale bars = 1mm.

By considering only leaf features, it results that *Ornithogalum montanum* (subgen. *Oreogalum* Zahar.) and *O. comosum* (sect. *Obtusangula* Zahar.) are the most distinct species, maintaining some ancestral character close to *Loncomelos*. *O. gussonei* and *O. collinum* (both belonging to subgen. *Hypogaeum* Zahar.) are also rather isolated. *O. umbellatum* cycle (subgen. *Ornithogalum sensu strictissimo*) is fully recognised, as *O. exscapum*

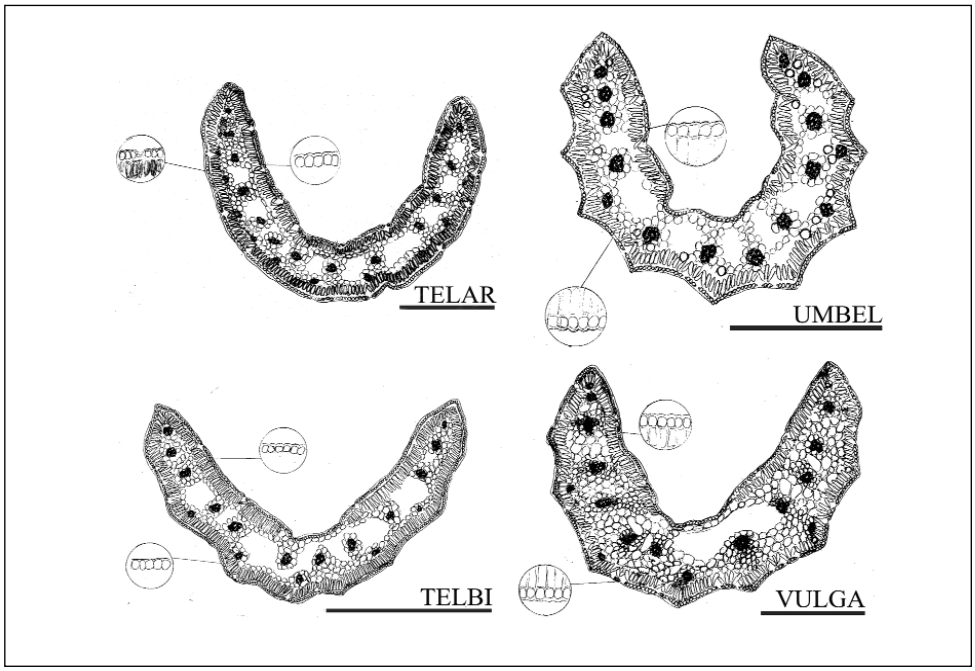

Fig. 3. Leaf cross sections: *O. televrinum* (TELAR, TELBI), *O. umbellatum* 3x (UMBEL), *O. umbellatum 4x* (VULGA); scale bars = 1mm.

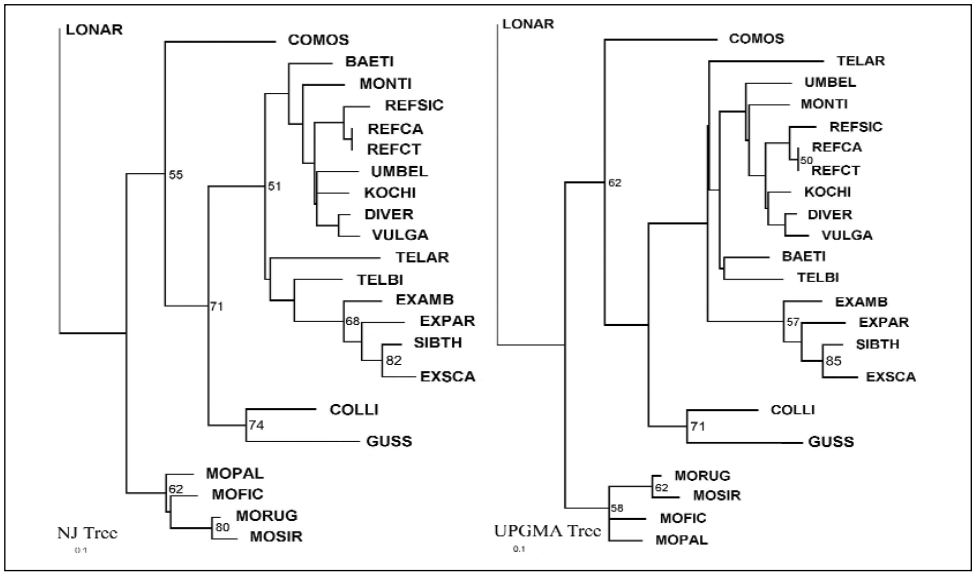

Fig. 4. NJ and UPGMA trees of the considered taxa. Bootstrap values above 50% are reported on the right of the nodes.

Table 2. Data Matrix. Character: **1** leaf cross section margins: 0 hairy-appendiculate, 1 appendiculate, 2 acute-appendiculate, 3 acute, 4 obtuse, **2** abaxial surface keels: 0 no, 1 low, 2 normal, 3 pronouced, **3** palisade in the middle of adaxial surface: 0 continuous, 1 reduced, 2 interrupted, **4** "channel-like" structures: 0 many, 1 few, 2 no, **5** adaxial cuticle in cross section: 0 almost linear, 1 undulate, 2 acute, 3 "curly-bracket"-like, **6** abaxial cuticle in cross section: 0 almost linear, 1 undulate, 2 acute, 3 "curly-bracket"-like, **7** leaves number: 0: 0-6, 1: 6-9, 2: 9-12, **8** leaves erect before flowering: 0 no, 1 yes, **9** leaf colour: 0 green, 1 glaucous-green, 2 hardly glaucous, **10** leaves present at flowering: 0 always, 1 often no, 2 no, **11** vascular bundles number: 0: many in 1 series, 1: >30 in 2/3 series, 2: 10-30 in 2/3 series, 3: <9 in 2 series, **12** leaf width: 0: >5 mm, 1: 2-5 mm, 2: <2 mm, **13** 30-Germination: 0 epigeal, 1 hypogeal.

		Character												
No	Taxa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1	LONAR	1	1	0	0	0	2	0	0	0	0	1	0	0
2	BAETI	2	2	2	1	1	0	0	0	0	0	2	1	0
3	COLLI	0	3	2	2	0	0	2	0	0	1	2	1	1
4	COMOS	0	0	0	0	0	0	1	0	2	0	1	0	0
5	DIVER	4	2	2	1	0	0	0	1	0	0	2	1	0
6	EXSCA	3	3	2	2	3	3	1	0	1	0	2	1	0
7	EXAMB	3	3	2	1	2	0	1	0	1	0	2	1	0
8	EXPAR	3	2	2	2	2	1	1	0	1	0	2	1	0
9	GUSS	4	1	2	2	0	0	2	0	0	2	3	2	1
10	KOCHI	3	2	2	?	0	0	0	1	0	0	2	1	0
11	MORUG	1	1	0	0	1	0	0	0	0	1	0	0	1
12	MOFIC	1	0	0	0	1	0	0	0	0	0	0	0	1
13	MOPAL	1	1	0	0	0	0	0	0	0	0	0	0	1
14	MOSIR	1	1	0	0	1	1	0	0	0	1	0	0	1
15	MONTI	3	3	2	1	1	0	0	1	0	0	2	1	0
16	REFCA	4	2	2	1	1	0	0	1	0	0	2	1	0
17	REFSIC	4	2	2	1	0	0	0	1	0	0	2	1	0
18	REFCT	4	2	2	1	1	0	0	1	0	0	2	1	0
19	SIBTH	3	3	2	2	1	3	1	0	1	0	2	1	0
20	TELAR	4	0	1	1	1	1	0	0	2	0	2	1	0
21	TELBI	3	2	2	2	1	0	0	0	2	0	2	1	0
22	UMBEL	4	3	2	0	0	0	0	1	0	0	2	1	0
23	VULGA	4	2	2	1	0	0	1	1	0	0	2	1	0

s.l. (subgen. *Amphigalum* Zahar.). Finally, *O. televrinum* seems to represent the connection between *O. umbellatum* and *O. exscapum* groups.

Leaf features in *Ornithogalum* result useful in order to group similar species, while often are not sufficient to characterize each single taxon, being so probably reliable for phylogenetic inference.

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